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BULLETIN NO. 5.

OF THE

ILLINOIS STATE MUSEUM

OF

NATURAL HISTORY

NEW GENERA AND SPECIES OF ECHINODERMATA.

BY S. A. MILLER AND WM. F. E. GURLEY.

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December 20, 1894.

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## NEW GENERA AND SPECIES OF ECHINODERMATA,

BY S. A. MILLER AND WM. F. E. GURLEY.

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### SUBKINGDOM ECHINODERMATA.

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#### CLASS CRINOIDEA.

#### ORDER CYSTOIDEA.

#### FAMILY HOLOCYSTIDÆ.

#### HOLOCYSTITES GYRINUS, n. sp.

*Plate I, Fig. 1, ventral view; Fig. 2, posterior view; Fig. 3, summit view.*

This species is large, and if the almost perfect specimen, which we have illustrated, possesses the normal form of complete development, then it became free in the later stages of growth, for a scar at the terminal point, indicates an attachment to some foreign object in a younger state. The specimen is a little depressed dorso-ventrally. It is broad and rounded at the summit, followed immediately below by a sac-like swelling, from which it is continued in an obconoidal form until it terminates in an obtuse point. The fanciful resemblance, in the general outline, to a tadpole suggested the specific name.

Commencing at the base or lower end, there is a solid obconoidal piece nearly as long as its greater diameter, which is followed by a range of eight unequal, irregular, and more or less elongated plates. Two plates are inserted between this range and the next on the right part of the ventral side. There are eleven large and elongated plates in the second range, and three plates are inserted on the posterior side, between it and the next range. There are thirteen large, irregular and elongated plates in the third range and nineteen plates in the fourth range. The fifth range consists of plates more irregular in their order of arrangement and still more

variable in size. Above the fifth range the plates are not disposed in ranges nor in any other defined order, and differ so much in size and shape, that one can hardly say how many ranges they would make if disposed in some order. We would estimate, if they were in ranges, there are above the fifth range and below the mouth about seven or eight ranges; or between the basal piece and the mouth about twelve or thirteen ranges. Our specimen is most ventricose on the right side, and there is a base of a young cystidean at the lower side of the mouth and another immediately below one of the arm bases and some smaller bases on other parts of the body.

Looking at Fig. 3, the mouth may be seen on the upper side of the figure, two arm bases on the right and one on the left, connected by a Y shaped ambulacral furrow, and in the central part, between the mouth and the ambulacral furrow, what has been supposed to be the small anal opening. The mouth is on the margin of the anterior end and appears to have been surrounded by six plates, but the cystidean base covers the lower side of it, and hence, possibly, there are seven plates. The anal (?) opening is small and at the summit of a cone which is on the line of two plates. The ambulacral furrow is at the extreme summit and connects the three arm bases by following the sutures between the plates; the plates are denticulated or united by a zigzag line at the bottom of the furrow. Each plate that supports an arm is thickened and prominent and the ambulacral furrow is continued across this plate to the top of the prominence, where the cicatrix shows the place to which the arm was attached. The arms are not preserved. On each side near the bottom of the ambulacral furrow there is a row of pores, but a free plate of the same character from the same or a similar species, when examined from below, does not show these pores in lines, nor can they be distinguished from the other pores that penetrate the plate from all sides. The ambulacral furrow, therefore, is not homologous with the ambulacral furrows of either crinoids or blastoids. There is no reason to suppose that it was a food groove, was covered with minute plates, or was furnished with pinnules. It appears as a triangular furrow cut only half way through the plates, and where following the suture lines of plates, the plates are more firmly joined than elsewhere by the denticulated edges, but when it enters upon a plate that bears an



arm, the furrow runs up to the base of the arm where it does not cut one-fourth of the thickness of the plate, and where the pores upon the sides appear to differ from the other pores that penetrate the plate only by being arranged externally in two lines. The physiological functions of this furrow are unknown.

We do not desire to be understood as laying any stress on the word *arms* used above, for so far, no arms, in the true sense, have been found in this genus. Instead of that we have had ambulacral spines, in some species, and in others no indications of spines. In this species there may have been only spines instead of arms possessing any kind of movement. All of the plates are poriferous, some much more densely poriferous than others; even the basal plate is poriferous. The pores generally penetrate the plates in pairs.

This is a remarkable species, on account of the Y-shaped furrow that connects the three arm or spine bases, and it is distinguished from all others by its peculiar form, size and the plates covering the body.

Found by J. F. Hammell in the lower part of the Niagara Group, in Jefferson county, Indiana, and now in his collection.

HOLOCYSTITES SPLENDENS, n. sp.

*Plate I, Fig. 7, left anterior view or most ventricose side; Fig. 8, right posterior view or least ventricose side; Fig. 9, summit view.*

This species is rather below medium size, balloon shaped or somewhat pear-shaped and our specimen is most ventricose on the left anterior side. It was sessile and the cicatrix for attachment is plainly preserved. The whole body is pustulose and every pustule is pierced by a pair of pores. There are also a number of large round cavities or hemispherical depressions irregularly distributed over the body, as shown in the illustrations, the purpose of which is wholly unknown. It has been supposed that they are marks of disease, and that the fact that the whole order of cystideans, soon after their great abundance in the Niagara Group, became extinct, gave color to the supposition, but we have no evidence that they are marks of disease.

Commencing at the lower end, we have, first, a small, round piece that attached to some foreign object, but which is papillose and pierced with pores just as the plates are above. It is

followed by a range of eight small plates. There are eight larger plates in the second range and eight still larger plates in the third range without any intercalated plates. Between the third range and what may be called the fourth range there are twelve small plates, principally on the ventricose side. There are eight large plates in the fourth range. Above the fourth range the plates are polygonal of variable size and irregularly disposed. If they could be thrown into ranges there would be six or seven ranges between the fourth range and the mouth.

The ambulacral orifice is somewhat marginal, but at the summit. It is subpentagonal in outline, about twice as wide as long, and surrounded with seven plates. There are scars for five spines. Two plates separate the ambulacral orifice from the mouth. The mouth is hexagonal in outline and located subcentrally, or about one-half its diameter anterior to the center, and is lower than the ambulacral orifice. A large pustule on the plate adjoining the mouth and between it and the ambulacral orifice bears a large pore that is called the anal opening.

The specimen from which this species is described is almost as perfect, so far as the outer test is concerned, as it was the day the animal died. It is so different from all hitherto described that no comparison with any of them is necessary.

Found by J. F. Hammell, in the Niagara Group, near Madison, Indiana, and now in his collection.

#### FAMILY ANOMALOCYSTIDÆ.

##### BELEMNOCYSTITES, n. gen.

[Ety. *belemnion*, dart; *Kustis*, bladder.]

Body compressed, moderately convex in the central part on both sides, but margin thin; outline ovoid. The plates are not disposed in ranges or series. A marginal rim of plates that covers an equal portion of both the dorsal and ventral sides is a peculiar character of this genus. Within this marginal rim there are a few large convex plates, on the dorsal side, without any arms or apertures. Within the marginal rim, on the ventral side, the plates are more numerous and an arm arises in the anterior part,



but the openings are unknown. Column comparatively large composed of thin plates and tapering as in *Steleocystites*. Type B. *Wetherbyi*.

BELEMNOCYSTITES WETHERBYI, n. sp.

*Plate I, Fig. 4, dorsal side of a specimen with part of the column attached; Fig. 5, dorsal side of another specimen with column and part of the plates broken off; Fig. 6, ventral side of same, part of the plates only being distinguishable.*

In 1881 Professor A. G. Wetherby, in an article entitled "Descriptions of New Fossils from the Lower Silurian and Subcarboniferous Rocks of Kentucky," published in Jour. Cin. Soc. Nat. Hist., vol. 4, p. 177, pl. V, figs. 2 and 2a, called attention to a "new genus and species" of cystideans, without attempting to give it a name or determine its affinities. Fig. 4 is a reproduction of his figure 2, which is, evidently, the dorsal side of the specimen. He said of it: "The column is round and tapers rapidly. The peculiar character of this anomalous fossil is the presence of a single arm, originating between two large plates which form the apex of the body on the (ventral) side. Seven plates of the arm are shown. Near it, upon the left side, as shown in the figure, is a small tubercle, evidently formed by valvular plates now silicified so as to obscure their arrangement." Our specimen, as shown in figures 5 and 6, is just like his, except the lower part is broken away, and we have attempted to give a better view of the ventral side than is shown in his figure 2a. We have given him the honor of the specific name.

Body compressed, convex on each side, within the marginal rim of plates, outline subovoid, truncated at the base for the attachment of a large column, which is composed of thin plates and tapers rapidly.

There are nine plates in the marginal rim, not including the two which abut upon the column. Five on one side and four on the other. These plates are large and sutures distinct. The sutures are exactly opposite each other on the two sides and are plainly shown curving over the margin, which is thin and sharp. This peculiar rim of plates increases in thickness on the ventral

side toward the central part of the body, which renders it probable that they are furrowed within so that a transverse section would be somewhat V-shaped, though they are depressed on the dorsal side. In no part of this rim is there any evidence of pectinated rhombs, pores or arms.

On the dorsal side of our specimen, there are only five plates preserved within the marginal rim, but figure 4 shows there are seven plates, two of which abut upon the column. The three superior plates are subconical. The outer surface is destroyed by silicification.

On the ventral side, there are evidently more plates within the marginal rim, but part of them cannot be distinguished, in our specimen, because the silicification has obscured the sutures. The ventral side is much more convex than the dorsal. The single arm to which Wetherby referred arises between plates, within the marginal rim of plates, and not from the apex of the body by any means. This is shown by his illustration as well as by ours. We cannot distinguish the arm plates, in our specimen, but the projection seems to be that of an arm. We are not able to distinguish any openings, but the tubercle, to which Wetherby referred, is on the left of what we have called the column, though it is not shown in our illustration, and we are not sure that it indicates anything beyond the convexity of the plate.

Found in the Trenton Group, in Mercer county, Kentucky, and now in the collection of Wm. F. E. Gurley.

### FAMILY CARYOCRINIDÆ.

#### CARYOCRINUS ELLIPTICUS, n. sp.

*Plate II, Fig. 13, anterior side view; Fig. 14, summit view.*

Species below medium size, subelliptical in outline, somewhat angular below, but round in the central part. Sharp ridges radiate from the center of the plates to each angle, except on the basal plates, where a sharp ridge runs from each of the two superior angles on each plate, to the point of columnar attachment. There is a single row of pores on each side of these angular ridges, but none elsewhere on the plates.

The four basal plates are of unequal size and form a cup less than one-third the length of the body. The strong longitudinal

ridges give it an hexagonal outline. The base is rather deeply excavated for the insertion of the column. The six plates in the second range are of unequal size and the larger ones follow the smaller basal plates so that the symmetry of the body is restored, two are pentagonal, two hexagonal and two heptagonal. These plates bear sharp ridges radiating from the center to each angle. There are eight plates in the third range of unequal size and different in outline. The summit is covered with very convex plates. The mouth is near the margin, slightly elevated and surrounded by four convex plates, one of which is much larger than the others. The central plate is heptagonal and surrounded by seven plates. There are several smaller plates on the vault. There are nine arm openings to the vault.

This species is probably more nearly related to *C. indianensis* than to any other described species. It differs, however, in the general form and in the absence of the constriction below the arms. The third range of plates are not alike in the two species and the vaults are different. That species has twenty-one arms disposed in clusters; this one has only nine, and they are not in clusters. The plates of the vault in that species bear pores and pustules, while in this the plates are smooth and convex. There are pores and pustules between the radiating lines in that species and there are none in this. The surface ornamentation will readily distinguish the species as well as the general form.

The specimen illustrated is from the Niagara Group, at Osgood, Indiana, and is in the collection of S. A. Miller. Four specimens are in the collection of Wm. F. E. Gurley, from the Niagara Group, at St. Paul, Indiana, and they seem to differ only in bearing higher and sharper radiating lines.

CARYOCRINUS BULBULUS, n. sp.

*Plate II, Fig. 15, anterior side view showing mouth at the summit and arm openings laterally; Fig. 16, posterior view; Fig. 17, summit view; Fig. 18, basal view of same.*

Body bulbous, or subovoid, subpyramidal from the column to the middle of the second range of plates, where, by reason of the central protuberances on the plates, it is hexagonal; above this, it is less angular, but the mouth is produced above the rest of the

summit, which is somewhat flattened behind the mouth. The surface, as it appears on our two specimens, one of which is unaltered limestone and the other silicified, is smooth. There are no radiating lines or ridges, granules or pustules and there are no pores that can be discovered with an ordinary magnifier.

The four plates, in the first range, form a subhexagonal cup about one-third of the length of the body, which has a small hemispherical depression at the bottom for the insertion of a column. The six plates in the second range are of unequal size, four are hexagonal, one pentagonal and one heptagonal; all are longer than wide, except the heptagonal plate, which is fully as wide as long. Each plate is subpyramidal externally, that is, produced centrally in the form of a node, which gives to the central part of the body its hexagonal outline. A cast, however, would not, probably, preserve this hexagonal outline and might be perfectly round.

There are eight plates in the third range of unequal size and different in outline. Two hexagonal plates stand nearly upright and abut upon the mouth, with their superior angles between the mouth and an arm opening on either side. Six of the plates rest between the superior lateral sides of the plates of the second range and two of them, each, truncate a single plate in the second range. The latter two are the smaller plates in the range. All of the plates of this range except where truncated by the mouth and arm openings abut upon the plates of the vault.

There is a subcentral plate on the vault, but the sutures between the plates in our specimens are not distinct, and we are not certain, therefore, as to the number of plates surrounding it; apparently there are only six, but probably there are seven. There are only six armholes that are clearly distinguishable on the limestone specimen, but there appear to be nine in the silicified specimen.

This species is widely separated from all hitherto described, but there is no doubt about the generic relations.

Found in the Niagara Group, in Wayne county, Tennessee, and now in the collection of Wm. F. E. Gurley.

## ORDER AGELACRINOIDEA.

## FAMILY HEMICYSTIDÆ.

## AESIOCYSTITES, n. gen.

[*Ety. aisios*, auspicious, coming at a good time; *Kustis*, bladder.]

Body highly convex or hemispherical; free, not parasitic. We say free, because the plates preserved in our specimens are continued over the margin and part of the truncated side, and the arms also curve over the margin before they terminate. The truncated side is depressed in our specimens and is not preserved so as to offer an opportunity for an intelligent description. Plates of the interbrachial areas non-imbricating and not coalescing with the outer plates of the arms. Arms five, very large, highly convex, radiating from the center and curving over the margin before they terminate. They are composed externally of a double series of alternating and interlocking plates; when these plates are removed deep gutters are disclosed, which are angular at the bottom, and unite in an elliptical hole at the center, which connects with the visceral cavity below. The ambulacral furrows and central orifice are completely covered with the alternating and interlocking arm plates. One interbrachial area is larger than the others and the anal or ovarian pyramid is situated in it, eccentrically, approaching the margin.

This genus is readily distinguished from *Hemicystites*, which is a parasitic genus, composed of imbricating plates that coalesce with the arms, which are limited by a marginal rim of plates. Type *Aesiocystites priscus*.



## AESIOCYSTITES PRISCUS, n. sp.

*Plate II, Fig. 10, summit view with the outer plates of the arms silicified and showing the position of the anal or ovarian pyramid, Fig. 11, summit view with the arm plates removed and disclosing the arm furrows, the central orifice and the position of the anal or ovarian pyramid; Fig. 12, lateral view from which the external plates of the arms have been partly removed and showing the interbrachial plates.*

The specimens upon which this genus and species are founded are silicified and the sutures between the plates more or less destroyed. The under side of all of them is broken in or damaged so that a full knowledge of it cannot be obtained.

The general form is hemispherical, with truncated margin rounded and radial ridges elevated and angular. It is composed of polygonal and non-imbricating plates, the largest of which are in the interbrachial areas. The interbrachial areas are distinctly defined on the convex side and the plates curve over the inferior margin and on the truncated side without interruption. The arms are very large, highly convex, and angular on the summit. They radiate from the center in such manner as to leave one interrachial area larger than the others, with an arm directly opposite, and this lengthens the central arm elevation toward the two arms upon each side. The arms bend over the margin and then gently curve and terminate on the truncated side. Externally they consist of a double series of short alternating and interlocking plates, which cover large, deep and angular ambulacral furrows. The form of the plates in the bottom of the ambulacral furrows is not determined. The central orifice, from which the ambulacral furrows radiate, is sub-elliptical in outline, being lengthened with the central arm elevation and covered externally with the arm plates. The large area above described is the azygons area and the anal or ovarian pyramid and orifice is situated in it, eccentrically, near the margin.

This species is founded upon four specimens, in two of which the external arm plates are removed, and one of these preserves



a large part of the truncated side showing the curving and terminating ends of the arms. One of the other specimens shows part of the interlocking arm plates and the other shows the covering of the arm furrows almost complete. Whether there was a gaping of the arm plates at the ends of the rays or not is not determined, but it is quite probable that they did, as such is frequently found to be the case in Hemicystites.

Found in the Trenton Group, in Mercer county, Kentucky, and now in the collection of Wm. F. E. Gurley.

### FAMILY AGELACRINIDÆ.

#### AGELACRINUS LEGRANDENSIS, n. sp.

*Plate III, Fig. 13, two specimens, natural size, the smaller one not as well preserved as the larger one; Fig. 14, same magnified two diameters.*

The species in this genus seem to vary greatly in size, and we have no doubt the two specimens illustrated belong to the same species though the smaller one is not so well preserved as the larger and may not furnish all the evidence necessary to warrant a satisfactory conclusion in this respect. It is also quite probable that the larger specimen does not reach the maximum size of the species.

The body is circular and only slightly convex. The outer rim is composed of numerous small, squamiform, imbricating plates, those upon the outer margin of it are so minute as to be almost granular. The plates of the disc within the outer rim are also squamiform and imbricating and somewhat larger than any of the plates in the outer rim. There are only four arms, three of them curve slightly to the right and one to the left. The arms are slender and each consists of an angular ridge, composed of interlocking plates, and terminates after curving slightly on the inside of the outer rim. The central part from which the arms radiate is more convex than any other part of the body, but the plates are so small that no peculiar structure is discernable. The specimens are somewhat injured in the region of the aperture and apparently it is not at the center between the sinistral and dextral arms, but between that point and the central elevation.

This species is about the size of *Agelacrinus blairi* but the plates are smaller and the body is probably less convex. It is the only species yet known from the rocks of the Kinderhook Group, and also the only one that bears four arms.

Found in the Kinderhook Group at LeGrand, Iowa, and now in the collection of Wm. F. E. Gurley.

AGELACRINUS PULASKIENSIS, n. sp.

*Plate III, Fig. 18, a specimen showing the ovariou or anal pyramid.*

Species large, body circular and with more than the usual convexity. The outer rim is composed of numerous large squamiform plates, that imbricate inward from the periphery, those near the margin being the smaller, as in all other known species in this genus. The plates of the disc within the outer rim and between the arms are large and imbricating, though a few of them appear to be very slightly imbricating. There are five very long, slender, curving arms, forming convex ridges, four of them sinistral and one dextral. The central part of the arms, so far as shown in our specimen, consists of a double row of interlocking plates, which are supported by large plates laterally, that rise nearly as high as the central plates. The central part from which the arms radiate is more convex than any other part of the body and is covered with numerous small plates. The ovarian or anal aperture is situated about the middle of the largest inter-brachial area and surrounded by the dextral and one sinistral arm. It is a depressed convex, circular prominence covered with twelve cuneiform plates. The surface of the plates is finely granular.

This species has some resemblance to *Agelacrinus cincinnatiensis*, but the arms are longer, body more convex, ovarian aperture larger and covered with more large plates.

Found in the Kaskaskia Group in Pulaski County, Kentucky, and now in collection of Wm. F. E. Gurley.

## FAMILY RHODOCRINIDÆ.

## ARCHÆOCRINUS PECULIARIIS, n. sp.

*Plate II, Fig. 1, lateral view of a specimen slightly compressed laterally; Fig. 2, azygous view of same, showing the curved radial series with an azygous plate over the first radial; Fig. 3, basal view of same.*

Species large. Calyx globose; greatest diameter about the top of the second primary radials and very slightly exceeding the height; constricted below the arms; plates convex and free from radial ridges; sutures beveled; surface granular.

Basals small, deep within the calyx and covered by the column. Subradials longer than wide and truncated at the superior ends by the first interradians. The inferior ends curve abruptly into the columnar cavity and are notched so as to give a subpentagonal outline to the columnar cavity, which indicates that the column (which is unknown) is pentagonal. These plates curve gently upward so that the calyx will rest below the middle and show half the length in a side view.

Four of the first primary radials are pentagonal, about equal in size, and about as wide as high. The other one is hexagonal, has unequal sides and is the largest plate in the calyx. It is on the left of the azygous area and supports on its upper side an azygous plate and upon the left superior lateral side the second primary radial, as shown in the illustration.

Four of the second primary radials are hexagonal, about the same size as the four first primary radials and nearly as high as wide. The other one is pentagonal, somewhat smaller and inclined so as to present a horizontal upper face for the support of the third primary radial, as shown in figure 2.

Third primary radials very little more than half as large as the second, smaller than the adjoining interradians, of about equal size, about as wide as high, pentagonal, and support on each upper sloping side a single secondary radial. Secondary radials a little more than half as large as the third primary radials, hexagonal and support upon the inner upper sloping sides a secondary interradian, and upon the superior faces a single tertiary radial, and upon the outer upper sloping sides two tertiary radials (?). Our specimen is not preserved beyond these plates. There are, therefore, twenty (?) arms arising from the calyx.

There are eight plates in each regular interrarial area. The first ones are the largest plates in the calyx, excepting, only, one of the first primary radials. They are heptagonal, longer than wide, truncate the subradials and extend nearly as high as the second primary radials. There are two plates in the second range equal in size, and larger than the third primary radials. These are followed by three much smaller and somewhat elongated plates in the third range, and these, in turn, are followed by one plate in the fourth range, which reaches as high as the tertiary (?) radials above described, and which, we suppose unites with the plates of the vault, as we suppose the single secondary interradians did. No part of the plates of the vault is preserved, in our specimen, neither are any of the arm openings to the vault, and it is, therefore, probable that the plates which we have called tertiary radials on the outer upper sloping sides of the secondary radials are interradians, and, if so, only ten arms arise from the calyx, which are separated by wide interrarial areas connecting with the vault.

The azygous interrarial area differs from the regular interrarial areas chiefly in the fact that it contains an additional, large plate, in the second range, which occupies the usual position of a second primary radial. Take out this long heptagonal plate and close up the space by straightening the crooked primary radial series and then all the interrarial areas will be substantially alike.

The absence of radial ridges, general form of the calyx, number of interradians and peculiar position of the large heptagonal plate in the second range of azygous interradians will distinguish this species from all others hitherto described. Walter R. Billings figured and described three plates, in the second range, in the azygous area, of *Archæocrinus desideratus*, but the additional plate is like other plates, in the second range of the interrarial areas, and did not disturb the adjacent primary radial series. We do not consider the absence of radial ridges or peculiar position of the azygous plate as of more than specific importance and hence have no hesitation in referring this species to the genus *Archæocrinus*.

Found in the Trenton Group in Knox County, Tennessee, and now in the collection of Wm. F. E. Gurley.



## ARCHÆOCRINUS ASPERATUS, n. sp.

*Plate II, Fig. 7, basal view, azygous side below; Fig. 8, summit view, azygous side below and matrix covering some of the plates on the right; Fig. 9, azygous side view.*

Species medium size. Calyx bowl-shaped, subpentagonal in outline, more than twice as wide as high; radial ridges interrupted at the sutures; plates subspinous or very convex and more or less sculptured; surface granular; columnar cavity wide, deep, and sculptured so as to indicate a pentagonal column.

Basals small, deep within the calyx, but not covered by the column, in fact, the column enters the cone formed by the basals leaving the basals abutting the subradials outside the circumference of the column. Subradials large, longer than wide, abruptly bent into the columnar cavity and upward between the radials, leaving a transverse ridge across the middle part of each, from each end of which a radial ridge arises, that unites with another in the central part of each first primary radial. The calyx will rest upon these ridges as the sculpturing is deep. The azygous subradial is octagonal the others are heptagonal, the shorter sides abut upon the basals and adjacent subradials, the longer sides support the radial series while each is rather broadly truncated at the superior end.

Three of the first primary radials are pentagonal, the other two, on the right of the azygous area, are hexagonal. They are all wider than high, the shorter sides abut the interradians, the longer sides the subradials and second radials. The superior side that abuts the second radial is arcuate externally. The inferior angle of each is sunk in a deep pit, the central part of the plate is convex from which a radial ridge extends to each adjacent subradial, while the greatest prominence exists in the upper part.

Four of the second primary radials are hexagonal and one pentagonal, they are of unequal size and vary from a little wider than long to more than twice as wide as long. All of them are longitudinally convex in the central part and bear central nodes. The third primary radials are smaller than the second, of unequal size, pentagonal, axillary, and support upon each upper sloping side two small, short, secondary radials before reaching the free arms. The second and third primary radials together are not larger than the first. The radial ridge in each series continues across the

secondary radials and unites with the convex outer surface of the arms. There are ten arm openings to the vault. There is a single small intersecondary plate, in each area, that is followed by a larger and longer plate, which separates the bases of the arms and unites with the plates of the vault.

The first interradians are the largest plates in the calyx, they are subpyramidal and terminate in an acute, central point. They broadly truncate the subradials, separate the primary radials, in in some areas, and, in others, both the primary and secondary radials, and are each followed by five or six plates, in the form of a yoke or arch, that reaches down half or more than half the length of the first interradiation. They have, therefore, eight, nine or ten sides, depending on whether or not they abut the second primary radials, and whether there are five or six plates in the yoke. The three or four superior plates of this arch separate the secondary radials and are followed by three or four plates that separate the bases of the arms and unite with the plates of the vault. The number of plates in the regular interradiation areas are, therefore, not quite uniform, and they graduate into the plates of the vault so as to leave no distinct line of separation.

In the azygous interradiation area two plates truncate the subradial, one large, the other small. The large plate corresponds with the first plate, in the regular areas, and has only eight sides, one of which rests on a subradial, another against a first primary radial, another against a second primary radial, and the others against five plates, that form a yoke, as in the other areas, except one side of it reaches a subradial and separates the large plate entirely from one radial series. The area is wider than the regular areas and the plates are somewhat larger, but not more numerous. The superior plate in the yoke extends a little higher than the plates in the regular areas, it unites with plates, at the bases of the arms, and others that extend to the vault, as in the other areas, though not exactly in the same order of arrangement.

The vault is elevated over the arm furrows, convex on the azygous side of the proboscis, but somewhat flattened on the other side. The proboscis is subcentral. The vault is covered by numerous polygonal, highly convex plates and is moderately depressed toward the interradiation areas. The proboscis is broken off, but so far as preserved, it is small, round and composed of small, highly convex plates.



This species is probably as nearly related to *Archæocrinus sculptus*, which we suppose was collected in the same group of rocks, as to any other, but the structural differences are so marked that no comparison is necessary.

Found in the Trenton Group, in Knox County, Tennessee, and now in the collection of Wm. F. E. Gurley.

ARCHÆOCRINUS PARVUS, n. sp.

*Plate II. Fig. 26, basal view; Fig. 27, azygous side view; Fig. 28, summit view.*

Species small; calyx saucer-shaped subpentagonal in outline, more than twice as wide as high; radial ridges not distinguished and interrupted at the sutures; plates sculptured; surface granular; columnar cavity of moderate depth and indicating by its shape a pentagonal column.

Basals sunk within the calyx and showing a pentagonal outline beyond the circumference of the column. Subradials longer than wide, sharply bent into the columnar cavity and upward between the radials, leaving a pentagonal cavity below bounded by a sharp, angular ridge, upon which the calyx may rest, showing the subradials in a side view.

First primary radials sculptured, wider than higher, pentagonal. Second radials twice as wide as high, hexagonal. Third radials short, pentagonal, axillary, and supporting upon each upper sloping side the secondary radials. No tertiary radials. Ten arm openings to the vault.

First regular interradial large, sculptured and supporting two plates in the second range that separate the secondary radials and unite with the plates of the vault. First azygous interradial large and supporting in the second range three plates, the lateral ones small; these are succeeded by three plates that unite with the plates of the vault, the lateral ones uniting with the protecting sides of the ambulacral furrows.

Vault moderately convex and covered with polygonal convex plates, proboscis small and subcentral.

This species, though small and somewhat resembling *A. asperatus*, is so distinct as to require no comparison to distinguish it.

Found in the Trenton Group, in Knox County, Tennessee, and now in the collection of Wm. F. E. Gurley.

## FAMILY MITROCRINIDÆ, n. fam.

## MITROCRINUS, n. gen.

[Ety *mitra* a turban; *krinon* lily.]

Calyx depressed; vault elevated. Basals three, equal. Primary radials three by six. Secondary radials. No subradials. Regular interradials three. Azygous interradials three or more, the first one resting on a single basal.

The peculiarities in this genus are the six radial series instead of five, and the resting of the first azygous plate on a single basal instead of on two basals. Beside this genus is from the Trenton Group and is the only one having three equal basals, thus far known, from the Trenton rocks of America. Type M. *Wetherbyi*.

This genus cannot be referred to any of the described families, if any regard is paid to the structure of the calices. The specimen is quite complete, on which the genus is established. It is symmetrical in all its parts, and a line drawn through the center of the azygous area will cut it in two equal parts, leaving three radial series upon each. The three basal plates are almost absolutely equal, notwithstanding one of them supports an azygous plate. The vault is as perfect as that of any other crinoid and has a resemblance to that of a *Dorycrinus*. Under the circumstances we propose the new family name *Mitrocrinidæ* and ascribe to it the following characters: Basals three. Primary radials three by six. No subradials. Regular interradials. Whether other characters ascribed to the genus will be found to be of family value will depend upon future discovery of allied genera.

## MITROCRINUS WETHERBYI, n. sp.

*Plate II, Fig. 4, azygous view, the central spine may be seen beyond the azygous opening and two of the subspinous plates on the sides, but the plates of the azygous side are small and sutures too obscure for correct illustration; Fig. 5, basal view, azygous side above; Fig. 6, Summit view.*

Calyx depressed, radial elevations distinct, but not specialized as ridges; interradial areas concave; sutures slightly beveled; surface granular; height less than half that of the vault; arm openings directed horizontally.

Basals three, exposing externally a large heptagonal disc, the side on which the azygous plate rests being short and truncation slight. In the center there is a concave depression for the insertion of the head of the column which is surrounded by a pentagonal rim, too delicate for illustration, that indicates the column is pentagonal. First primary radials a little wider than long, superior face a little concave, three hexagonal and three heptagonal. Second radials more than twice as wide as long, hexagonal. Third radials twice as wide as long, pentagonal, axillary and bearing upon each superior sloping side secondary radials, giving to the species twelve arms.

There are three regular interradials in each area. The first hexagonal, longer than wide and succeeded by two plates in the second range, each of which is as large as the first one. These unite with the plates of the vault and those covering the ambulacral grooves. There is no boundary line between the plates of the calyx and vault as they graduate into each other in the interradial areas and the ambulacral coverings. First azygous plate pentagonal, rests on a single basal, and longer than wide; two plates in the second range which reach as high as the calyx proper and unite with the plates of the vault and ambulacral coverings. The azygous area is nearly perpendicular from the top of the first azygous plate to the summit of the vault, and, above the second range of plates, is covered by numerous smaller ones.

Vault ventricose, radial areas high. The larger plate occupies the summit and bears a short central spine or conical elevation. It is surrounded by eight plates, which are next in size, on the vault, all of which are convex and some of them somewhat conical. The other plates on the vault, including those on the radial and interradial areas, are polygonal, convex and granular. The azygous opening is separated from the central plate by three of the eight plates above described, as surrounding the central plate. It is broken, in our specimen, but does not appear to have extended higher than the central plate.

The specific name is in honor of Prof. A. G. Wetherby, to whose skill and untiring energy is due the discovery of this and the three preceding species as well as the locality from which they were obtained.

Found in the Trenton Group, in Knox county, Tennessee, and now in the collection of Wm. F. E. Gurley.

## FAMILY POROCRINIDÆ, n. fam.

This family has five basals; five subradials; one by five radials; no regular interradians; small arms; and deep pits and pectinated rhombs, at the angles of the plates. It resembles, in its general structure, the *Cyathocrinidæ*, and *Poteriocrinidæ*, but the azygous area is not like that of any other known genus and the pectinated rhombs are like those belonging to *Cystideans*.

## POROCRINUS KENTUCKIENSIS, n. sp.

*Plate II, Fig. 19, side view showing deep pits or pectinated rhombs and part of the arms, azygous side on the right.*

Calyx obpyramidal, pentagonal, in outline, with the angles at the center of the subradials and again at the arm bases. Height equal to the greatest diameter. Surface radiately sculptured from the center of each plate to the center of each adjoining one. The base of our specimen is slightly broken away so that the true length of the basal plates is not shown in the illustration. The subradials are the largest plates in the calyx and occupy more than one-third of the length. The first radials are next in size and a single, small, round arm, occupying about one-third the width, arises from the superior central part. Only three short plates in three of the arms are preserved in our specimen, but the ambulacral furrows may be seen extending to the central part of the vault. The third plate is not axillary and hence the arms do not bifurcate on that plate if at all. There are two azygous interradians that seem to be arranged as in the type of the genus, but our specimen is silicified and the sutures are very indistinct. The vault is quite convex in this species. There is a very large pectinated rhomb at each angle of every plate in the calyx and smaller ones on the vault. Twenty-eight can be distinguished in our specimen.

The general form, surface ornamentation and exceedingly large pectinated rhombs at once distinguish this species.

Found in the Trenton Group, in Mercer county, Kentucky, and now in the collection of Wm. F. E. Gurley.



## FAMILY CYATHOCRINIDÆ.

## CARABOCRINUS OVALIS, n. sp.

*Plate II, Fig. 20, azygous side view; Fig. 21, opposite view.*

Our specimens are silicified and part of the plates in the arms do not show the sutures. Calyx suboval in outline, the smaller end below, which is narrowly rounded, and the scar for the attachment of the column very small. Surface destroyed in silicification. Basal plates small. Subradials the largest plates in the calyx, wider than high and evenly rounded. The radials are the next in size, very evenly rounded and slightly truncated about one-third the width in the superior central part for the free arms. The arms are small and round and bifurcate on the second plate. They bifurcate again on the third or fourth plate, the silicification destroying the sutures. And one of the arms in every ray bifurcates again, making thirty arms in this species. The arms cluster together over the vault and are so interlaced that more divisions of the arms may take place which are not disclosed by either of the two specimens before us. The azygous plates are arranged as in *Carabocrinus radiatus*, but the first plate which truncates a basal plate is regularly hexagonal and about as wide as high, and thus differs in form from *C. radiatus*. The second plate is smaller and truncates a subradial. The third plate is fully as large as the first and longer than wide.

The general outline of the calyx in this species is much like *Carabocrinus vancortlandti*, but the arms are quite different, as the first bifurcation, in that species, takes place on the third plate, while in this one, it takes place on the second plate. The general form of the calyx is altogether different from that in *C. radiatus*, but the first bifurcation takes place on the second plate in the free arms, in both species, though above that the arms are altogether different.

Found in the Trenton Group, in Mercer County, Kentucky, and now in the collection of Wm. F. E. Gurley.

## FAMILY GAUROCINIDÆ.

RETIOCRINUS ALVEOLATUS, n. sp.

*Plate 11, Fig. 22, azygous view.*

Column comparatively large and pentagonal. Calyx pentagonal, transversely. Basals extend but little beyond the column, deeply sunken or bearing a pit at each lower lateral side and a convex ridge directed to each adjacent subradial. Subradials longer than wide, the superior angle reaching almost as high as the first radials, and bearing four radiating rounded ridges, two of which unite with the basals below, and the others with the adjacent first radials. There is a large deep pit at each lateral angle. These pits in the calyx look like the pits or pectinated rhombs in *Porocrinus*. Our specimen is silicified, and the depth of these pits or whether or not they pass to the inside of the calyx cannot be accurately determined. The subradial on the azygous side bears an additional ridge that extends upward to the large plates in the middle of the azygous area.

There are four primary radials in each series, rounded externally and, at first view, looking like free arms, but there are small plates upon each side of the ambulacral furrow that unite with a central balloon-shaped body exposing the small plates in the interradial areas. There are four secondary radials in each series and they are connected, internally, with the central part of the body just as the primary radials are. The arms then appear to become free and each one bifurcates again from the fourth to the ninth plate, as near as the plates can be counted in our specimen. Thus giving to the species forty arms. In the azygous area there is a central row of large plates, looking like an arm, that extends as high as the secondary radials, and is connected with the central balloon-shaped body just as the primary and secondary radials are, except, of course, there is no ambulacral furrow, but a furrow nevertheless. The appearance of our specimen indicates the continuance of the balloon-shaped body, in the form of a proboscis, probably to the height of the arms, but there may be some doubt about it, as the arms are so numerous and so closely crowded together, that it cannot be clearly distinguished.



Billings described the genus *Retiocrinus* as follows: "This remarkable genus has no perfectly formed plates. The cup consists of a reticulated skeleton, composed of rudimentary plates, each consisting of a central nucleus, from which radiate from three to five stout processes. Of such plates there are five in the basal series, five in the subradial, and five in the radial series. On the azygous side the subradial has five processes; the others have four each."

The general appearance of the genus is that of a reticulated skeleton, as Billings described it, but the plates are all perfectly formed and not by any means rudimentary. The interradiial areas are abruptly sunken, and, as shown in our specimen, small plates connect the inner sides of the radials, with a central body, that is also covered with very small plates, which, if not so deeply depressed, would look somewhat like the interradiial areas in *Gaurocrinus*, and if they were not depressed, at all, they would look like the interradiial areas of *Glyptocrinus*, except they are covered with smaller plates. The ambulacral furrows in *Glyptocrinus* and *Gaurocrinus* enter the top of the calyx and unite centrally immediately below the vault, while in this genus they appear to follow down the radial series and to unite, at the lower part of the calyx, or between the subradials. The structure indicates this, but the channels forming the union have not been discovered. We have called this central cavity a balloon-shaped body, only for the purposes of description, for it is the same as the cavity of the calyx in other genera. Its form is only more balloon-shaped than an ordinary calyx because it is small in the lower half of the calyx. Even if the ambulacral furrows unite at the summit of the calyx, and not below, as we have thought most probable, the other structural parts are sufficient to warrant the generic name. No comparison of this species with any other is necessary to distinguish it, but it is interesting to note the finding of a new species in this rare genus, several hundred miles distant from the typical locality.

Found in the Trenton Group, in Mercer County, Kentucky, and now in the collection of Wm. F. E. Gurley.

## FAMILY GLYPTOCRINIDÆ.

GLYPTOCRINUS MERCERENSIS, n. sp.

*Plate II, Fig. 23, azygous side view.*

General form of the calyx, somewhat obpyramidal, transverse section pentagonal. Radial ridges prominent, plates deeply sculptured with stellate ornamentation. Interradial areas flattened. Column round and medium size.

There are five sculptured basal plates that extend in the form of a sharp ring below the top of the column. They are a little wider than high. The first primary radials are heptagonal, rather wider than high. The second primary radials are hexagonal, longer than wide and about two-thirds as large as the first. The third primary radials are heptagonal, abut upon two interradians, at each side, wider than high, about two-thirds as large as the second, axillary, and bear upon the superior sloping sides the secondary radials. There are three or four secondary radials in each series that enter into and form part of the calyx and then the radial ridge becomes more prominent and the arms become free. There are no tertiary radials and no divisions of the arms. There are, therefore, only ten arms in this species. The plates of the arms are short and the pinnules very dense.

The regular interradian areas have one large plate in each, resting upon the upper sloping sides of the first primary radials and separating the second primary radials. It is followed by two plates in the second range and above this the number cannot be ascertained from our specimens. In the azygous interradian area there is one large plate resting upon two first primary radials, which is followed by three plates in the second range, and above these the number of plates can not be determined in our specimens. A ridge arises at the center of the first azygous plate and extends straight up the center of the azygous area, a distance beyond the commencement of the free arms, and to the top of a proboscis. This species possesses a vault altogether different from that belonging to *G. decadactylus*, and it also possesses a proboscis or extension of the vault which has not been heretofore known to belong to any species of *Glyptocrinus*. In the region of the first and second

radials and first interradials, it resembles *G. decadactylus*, but is quite different in all other parts, beside having only ten arms. It can not be mistaken for any other described species.

Found in the Trenton Group, in Mercer county, Kentucky, and now in the collection of Wm. F. E. Gurley.

## FAMILY CALCEOCRINIDÆ.

### CALCEOCRINUS KENTUCKIENSIS, n. sp.

*Plate II, Fig. 24, anterior side view; Fig. 25, posterior side, showing place of attachment of the column of same specimen.*

From the cicatrix for the attachment of the column, we infer, that the body hung close to the column; the column is small and round. We have two specimens, about equally well preserved, both are silicified, but show the sutures correctly, unless it may be in the basal plate. The basal plate is triangular and, as shown by the sutures, composed of four anchylosed plates, though the sutures are obscure. The columnar facet is at the posterior angle. There is a wide gaping suture between the basals and the radials on the anterior side, that is somewhat denticulated on the anterior margin. Following this gaping suture on the anterior side there are three radials, in the first transverse series; the middle one is twice as long as wide, quadrangular, and constricted in the middle; the outer ones are hexagonal, about twice as wide and about twice as large as the middle one. The second transverse series commences in the middle part with a short wide plate that rests upon the superior side of the middle plate in the first series, and upon the inner sloping sides of the two lateral plates, in the first series. It is about three times as wide as long and is succeeded by a plate, that contracts rapidly upward, somewhat in the form of the frustum of a cone. It has a length about equal to the shorter width. This last plate bears a free single arm composed of rather long round joints. The superior lateral side of each of the lateral plates in the first series bears two brachial plates, the second one of which is axillary and bears free arms. Every second or third plate in the free arms is axillary, though one of the rays thrown off from each axillary plate is smaller than the main arm and does not bifurcate again.

Turning now to the posterior side, we find on the right a small intercalated triangular plate, and a brachial series of three plates resting upon the right side of the triangular basal and this intercalated triangular plate. This brachial series reaches about as high as the other brachial series, the last plate is axillary and bears free arms. Every second or third plate in these free arms is axillary, though one of the rays thrown off from each axillary plate is smaller than the main arm and does not bifurcate again. On the left of the posterior side we also find a small intercalated triangular plate, and a longitudinal azygous series resting on the left side of the triangular basal and this intercalated triangular plate. The azygous series consists of three large round plates, having a width more than twice as great as their length, and they are followed by a long round proboscis that extends beyond the limit of our broken specimens and probably beyond the length of the arms. The three azygous plates reach about as high as the brachials above described and in comparing with other crinoids this would be the limit of the calyx, and above this are the free arms and long proboscis. It will be understood that we have described this species as if it were standing up instead of hanging down from the end of the column.

It is unnecessary to compare this species with any others that have been described, though it is doubtless congeneric with the species described by W. R. Billings, and for which Ringueberg has described a genus under the name of *Castocrinus*. Probably, without hesitation it should be called *Castocrinus kentuckiensis*. But there has been so much blundering and bad work done with the *Calceocrinidae* and so many synonyms proposed, that we have thought, without taking the time now to review the subject, it would be sufficient to provisionally refer it to *Calceocrinus*, though we think, at present, that *Castocrinus* will be retained for this generic division of the family.

Found in the Trenton Group, in Mercer county, Kentucky, and now in the collection of Wm. F. E. Gurley.



## FAMILY POTERIOCRINIDÆ.

POTERIOCRINUS CIRCUMTEXTUS, n. sp.

*Plate II, Fig. 29, azygous side, showing the interlacing arms and proboscis; Fig. 30, opposite side of same specimen.*

Species medium size, with a remarkably large proboscis. Calyx cup-like, or somewhat obconoidal; truncated below for a moderately large column; wider than high; sutures distinct; surface smooth or very finely granular.

Basals one-fourth wider than high, pentagonal, gradually expanding. Subradials about as long as wide, three hexagonal and two heptagonal; those adjoining the azygous area are heptagonal.

First radials of unequal size, but about twice as wide as high, protuberant and rounded to the first brachials; hexagonal; the articulating scars occupy rather more than half the diameter of the plates and are directed outward and upward at an angle of about seventy degrees; a slightly gaping suture separates the first radials from the first brachials, and the superior faces of the first radials unite with the small plates that cover the vault.

There are four brachials in each of the lateral rays and three in each of the other three rays; they are short, rounded, and the last one supports upon each of its upper sloping sides free arms. All of the arms again bifurcate on the fourth plate, except one, and it bifurcates on the fifth plate. Every arm bifurcates again on plates ranging from the sixth to the sixteenth. At this height there are forty arms; some of them are seen to bifurcate again in our specimen, and probably all bifurcate again, making eighty arms in the species. The arms are round, plates long and sutures transverse.

The azygous area is wide and ventricose. The first plate is pentagonal, rests between the upper sloping sides of two subradials, separates the first radial on the right from the second azygous plate, and is truncated above for the third plate. The second plate is hexagonal, rather larger than the first, truncates a subradial, abuts the first radial on the left and the first and third plates on the right and supports two plates above. The third plate rests upon the first and is in line with the upper half of the second, supports two plates above and other plates on the



right. The first and third plates thus described support three plates in the next range, which are succeeded by plates of the proboscis.

The proboscis is large, long, cylindrical, and covered with polygonal plates. Round pores penetrate the proboscis throughout its length at nearly every angle of the plates, and, frequently, on the sutures between the angles. The vault is covered with small plates.

This species is more nearly related to *P. subramosus* than to any other which has been described, but it is distinguished from that species by the relative proportion of the plates in the calyx, by the number and position of the azygous plates, and by the great difference in the arms, and no doubt, also, in the character of the proboscis, which is unknown in that species.

Found in the Keokuk Group, at Crawfordsville, Indiana, and now in the collection of Wm. F. E. Gurley.

ZEACRINUS GRANDICULUS, n. sp.

*Plate II, Fig. 31, azygous view; Fig. 32, view opposite the azygous area.*

Body rather large, robust and elongate-ovate in outline. Calyx very low. Columnar cavity shallow. Surface smooth or finely granular. Column very small, round and composed of thin plates.

Basal plates within the calyx. Subradials with an acute superior angle, but invisible in a lateral view. First radials about one-half wider than long, rapidly expanding to the superior lateral angles, and truncated the entire width above for the support of the second primary radials. The inferior angles do not extend into the columnar cavity. Four of them are pentagonal, but two of them are separated by the extension of an azygous plate so as to reach the point of a subradial, and the one on the right supports two azygous interradians, as well as the radial series which gives to it an heptagonal outline. Four of the second primary radials are pentagonal, one-half wider than high, axillary, and support on each upper sloping side the secondary radials; but in the ray opposite the azygous area there are three primary radials, and consequently the second is quadrangular, twice as wide as high,

and supports the third, which is three times as wide as high, pentagonal, axillary, and supports upon the upper sloping sides the secondary radials.

In one of the secondary radial series there are three plates, in six of them each has four plates, in two of them each has six plates, and one of them has five plates. One ray which is opposite the azygous area, having six secondary radials, supports upon each upper sloping side tertiary radials, which continue to the end of the arms. Nine other tertiary radial series do not bifurcate, but so far as can be determined all the others bifurcate once, and one of the arms thus thrown off in each series bifurcates again, except in one ray. This gives us eight arms in each of four series, but only five arms in the ray opposite the azygous side, which possesses three primary radials, thus making thirty-seven arms in this species. But there is some injury to the specimen in two or three places, and the last bifurcation may not take place in one or two rays, and possibly, therefore, the species may have only thirty-six arms.

The azygous area commences with one plate, sending a sharp angle between the first radials to the angle of a subradial; this is succeeded by three plates in the second range, and these by three plates, and these again by two, the superior plate being the largest in the area and acutely pointed above. There are, therefore, nine azygous plates.

Found in the Kaskaskia Group, at Bowling Green, Kentucky, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS SCOPAE, Miller & Gurley.

*Plate III, Fig. 1, lateral view magnified two diameters; Fig. 2, lateral view of same specimen natural size, azygous area on the left.*

When the authors described this species in 1890 in their "Description of some new genera and species of Echinodermata from the Coal Measures and Subcarboniferous Rocks of Indiana, Missouri and Iowa," which work was subsequently reprinted in the 17th Report of the Geological Survey of Indiana, only the azygous side was illustrated, and, as it seemed desirable to have it further illustrated, two lateral views are here presented, one natural size and one magnified two diameters.

The specimen is from the typical locality, in the Kinderhook Group, at Le Grand, Iowa, and is in the collection of Wm. F. E. Gurley.

POTERIOCRINUS MACCABEI, n. sp.

*Plate III, Fig. 3, posterior side, natural size; Fig. 4, same magnified two diameters; Fig. 5, azygous side of same specimen magnified two diameters, part of the azygous area broken away, there is on this specimen a Poterivocrinus decrepitus showing the posterior side somewhat injured; Fig. 6, same, natural size.*

Species small, but bearing very long rugged or geniculated arms. Calyx obconoidal, as seen from the posterior side, but quite unsymmetrical on account of the development of the azygous area; height and greater diameter nearly equal; plates smooth. Column small, round.

Basals moderate size, in proportion to the calyx, with superior angles acute. Subradials a little wider than high, except one on the azygous side which has a length fully equal to the greater width; four of them are hexagonal, the other two are heptagonal. The azygous subradial, which is truncated at the top, is heptagonal and the largest plate in the calyx. The other heptagonal plate is on the right of the azygous area and is a little larger than either of the hexagonal plates. First radials one-third wider than high, quite convex longitudinally, which leaves the separating sutures much depressed, pentagonal and truncated the entire width above, where the sutures are slightly gaping. A single, long, rounded, brachial, supports upon the upper sloping sides, in each radial series, the free arms. These brachials are contracted in the middle part and of unequal length; the one opposite the azygous area is the longer, the two adjacent are the shorter, and the other two have an intermediate length. There are only ten arms in this species; they are long and composed of rather long, cuneiform, alternately projecting plates. Each projecting joint bears a large, tapering, long jointed pinnule, which gives to the arms a very rough or crisped aspect.

The azygous area is wide and covered with a double series of alternate plates. The first plate is pentagonal, longer than wide and rests between the superior sloping sides of two subradials and between the first radial on the right and the second azygous plate on the left and is truncated on top for the third azygous plate;

the second plate is hexagonal, larger than the first, rests upon the truncated upper end of the largest subradial and between the first radial and a summit plate on the left, and the first and third azygous plates on the right and is truncated at the upper end for the fourth plate. This alternate arrangement continues as far as the proboscis is preserved in our specimen.

This species is peculiar in its comparatively long, rough arms and wide azygous area. It need not be compared with any other described species, for *P. legrandensis* is as near to it as any other, and in that species there are twenty much shorter arms and a narrower and different azygous area.

Found in the Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

It was found by John McCabe, of Quarry, Iowa, in whose honor we take pleasure in dedicating this beautiful crinoid.

POTERIOCRINUS HAMMONDI, n. sp.

*Plate III, Fig. 7, azygous view, magnified two diameters; Fig. 8, same, natural size.*

Species small, but bearing long slender arms, which, when closed around the proboscis as in our specimen, make the body subcylindrical. Calyx obconoidal; height and greater diameter nearly equal; plates smooth. Column rather large at the calyx, but tapering for a short distance, when it becomes of ordinary size and consists of thin, round plates.

Basals of moderate size, in proportion to the calyx, with superior angles acute. Subradials hexagonal, wider than high, the one below the azygous area is much the wider, but so broadly truncated on top as to give it little if any greater length. First radials about as high as wide, evenly rounded, pentagonal, and truncated the entire width above, where the sutures are distinct but not gaping. A single, very long, contracted and rounded brachial, supports upon the upper sloping sides, in each radial series, the free arms. The contraction of these remarkably long brachials actually constricts the body immediately above the calyx. One of the lateral brachials is shown in our specimen, and it is a little shorter than either one adjoining the azygous side of the proboscis, and we may presume the one opposite the azygous area is the longer one, as that is the case in *Poteriocrinus maccabei* and in some other species. There are only ten arms in this species;



they are long and composed of long, slightly cuneiform, alternately projecting plates. Each projecting joint bears a small pinnule, which does not prevent the arms from closing tightly around the proboscis.

The azygous area is not large in this species. There is only one plate within the calyx, and it broadly truncates a subradial and separates two first radials. There appear to be two plates succeeding this one, but the arms in our specimen prevent further examination of the plates.

This species is peculiar in its long, delicate form, closed arms, long brachials and constriction above the calyx. The azygous area is also peculiar and we know of no species with which it is necessary to make any comparison in these particulars.

Found in the Kinderhook Group, at LeGrand, Iowa, and now in the collection of Wm. F. E. Gurley. The specific name is given in honor of Mr. L. A. Hammond, an enthusiastic collector of LeGrand, Iowa.

POTERIOCRINUS MACCABEI *var.* DECREPITUS, n. sp.

*Plate III, Fig. 9, azygous side of a depressed and somewhat injured specimen magnified two diameters; Fig. 11, same, natural size; Fig. 10, posterior view two diameters; Fig.*

*12, same, natural size; the posterior view of another specimen, magnified and natural size, may be seen on Poteriocrinus maccabei in Figs. 5 and 6.*

This is a small species bearing short rugged arms. Calyx obconoidal as seen from the posterior side, but unsymmetrical on account of the development of the azygous area. Diameter one half more than the height; plates smooth; column small, round.

Basals small and superior angles somewhat obtuse. Subradials one-half wider than high, except the one on the azygous side, which has a length about equal to the greatest width; four of them are hexagonal, the other two are heptagonal. The azygous subradial, which is truncated at the top, is heptagonal and the largest plate in the calyx. The other heptagonal plate is on the right of the azygous area, but is not larger than the hexagonal plates. First radials, one-third wider than high, quite convex longitudinally, which leaves the separating sutures much depressed pentagonal, and truncated the entire width above, where the



sutures are gaping. A single, rounded brachial supports upon the upper sloping sides in each radial series, the free arms. These brachials are contracted in the middle part and of unequal length; the one opposite the azygous area is the longer, the two adjacent are the shorter and the other two have an intermediate length. There are only ten arms in this species; they are short though composed of rather long, cuneiform, alternately projecting plates. Each projecting joint bears a large, tapering, long jointed pinnule, which gives to the arms a rough geniculated aspect.

The azygous area is covered with the same number of plates which are arranged in the same order that they occur in *P. maccabei*. The difference between the two is that in this species the area is proportionally narrower.

We have three specimens of this species which are free (and accidentally the best one is not illustrated) beside the one figured on *P. maccabei*, and they all bear the same proportions as to size of calyx and arms and size of the plates. The calyx in this species is fully as large as it is in *P. maccabei*, though slightly differing in form, the arms and pinnules are as coarse, but the arms have not more than two-thirds the length. The question then arises whether the minor differences which may be seen in the illustrations and the descriptions, coupled with the wider azygous area and longer arms in *P. maccabei*, are sufficient to distinguish species. One cannot be the young of the other unless age widened the azygous area and lengthened the arms without increasing the size of the plates, which is contrary to what we know of these animals. *P. maccabei* is graceful in its form and is not abnormal. Possibly the difference between the two should be regarded as of specific value, but we have not regarded it as of more than varietal importance.

Found in the Kinderhook Group, at LeGrand, Iowa, and now in the collection of Wm. F. E. Gurley.

ZEACRINUS SALEMENSIS, n. sp.

*Plate III, Fig. 17, lateral view, azygous area on the left.*

Our specimen is on a slab and the ray opposite the azygous area is not exposed. The species is of medium size. Calyx basin-shaped below the summit of the first radials and subpentagonal in outline in the superior part, deeply concave below; sutures distinct, surface granular.

Basals form a narrow pentagonal rim almost obscured by the column. Subradials abruptly bent upward and into the basal concavity, at about the middle part, about as wide as long. The one on the right of the azygous area heptagonal and broadly truncated for the first radial, the next one to the right hexagonal. First radials twice or more than twice as wide as high, pentagonal, truncated the entire width above and separated from the second radials by a gaping suture. Second radials larger than the first, about twice as wide as high, pentagonal, prominent almost nodose at the superior angle, and supporting on each upper sloping side the secondary radials. There are six secondary radials in each arm shown by our specimen, four of them are short plates with transverse sutures, the first one is the larger one and the last is pentagonal and supports upon each of the upper sloping sides the tertiary radials. One of the arms does not again bifurcate and consists of short flattened quadrangular plates. The other arm bifurcates again on the eighth plate and the arm adjoining the azygous side again bifurcates, and so does the corresponding arm in the other ray, which gives us seven arms to each of these rays.

The first azygous plate is pentagonal, abuts upon two subradials and the first radial on the right, and supports two interradials in the second range, one of which truncates a subradial. There are two interradians in the third range, beyond which they are not shown in our specimen.

It is not necessary to compare this species with any other for the purpose of distinguishing it.

Found in the Keokuk Group, at Salem, Indiana, and now in the collection of Wm. F. E. Gurley.

ZEACRINUS CYLINDRICUS, n. sp.

*Plate III, Fig. 19, a large specimen compressed antero-posteriorly showing azygous side; Fig. 20, a smaller specimen compressed laterally showing azygous side; Fig. 21, opposite view of same.*

This species is rather large and very long. The body is subcylindrical, though constricted above the calyx, slightly fusiform in the middle part, and slowly tapering above.

Calyx low, basin-shaped below the summit of the first radials, moderately concave below; plates convex; sutures distinct; surface granular. Column round and pierced by a very small, round central columnar canal.

Basals form a narrow pentagonal rim around the column about one-half wider than the diameter of the column. Subradials longer than wide, and curve into the basal concavity and upward, at about the middle part, so as to be visible in a side view. The curve into the basal concavity is abrupt and the middle part of each is depressed before uniting with the basal plates. Four are hexagonal and two heptagonal. First radials about one and a half times as wide as high, pentagonal, truncated the entire width above, and separated from the second radials by a gaping suture. Second radials smaller than the first, about twice as wide as high, pentagonal, and support upon each upper sloping side the secondary radials or free arms. There are, therefore, ten arms in this species. The arms are very long, subfusi form, and composed of a single series of short, quadrangular or slightly cuneiform plates. The pinnules are composed of subcylindrical pieces having a length equal to three diameters.

The first azygous plate is rather large, convex, pentagonal, rests between two subradials and the first radial on the right and abuts upon the second and third interradians. The second interradian truncates a subradial, is nearly as large as the first, and the succeeding plates are much smaller and alternately arranged as in other species of this genus.

This species has been confounded with *Z. maniformis*, by some collectors, but in that species the basal plates are hidden by the column, the body is shorter, and there are only nine arms, as the radial series opposite the azygous area bears only a single arm. It is still farther removed from all other species.

Found in the Kaskaskia Group, in Pulaski county, Kentucky, and now in the collection of Wm. F. E. Gurley.

## FAMILY PLATYCRINIDÆ.

## PLATYCRINUS CORTINA, n. sp.

*Plate III, Fig. 15, lateral view of calyx; Fig. 16, summit view with part of the vault, plates, grooves and pores preserved.*

Species medium or rather below medium size. Calyx goblet-shaped; about as high as wide; broadly truncated below; round and slightly contracted immediately above the base, highly convex and protruberant in the region of the arm-bases, so as to give it a marked pentagonal outline when seen from above. Plates thick. Sutures distinct. Surface papillose or very coarsely granular. Column small, round and attached to the base in a radiately lined hemispherical depression. Columnar canal very small and round.

Basals form a low, round cup, with a slightly expanded sharp rim at the base. First radials about as long as wide, expanding very little above the basals, longitudinally convex, and becoming very protruberant at the articulating facets for the second radials. Articulating facets for the second radials a little more than half the width of the plates and directed outward and upward at an angle of about seventy degrees. Second radials short, axillary and notched for the ambulacral furrows.

The vault, so far as preserved in our specimen, is only slightly convex. The first radials, between the arm bases, curve slightly toward the vault. There are three plates between the arm furrows, the lateral ones form part of the ambulacral covering and the middle one is an interrarial proper. There is a pit or pore at the junction of each interrarial with the two first radials at the dividing suture, and there is also a pit or pore on each side of the ambulacral furrows, at the suture lines of the first radials. Whether or not any or all of these are ovarian apertures we are unable to state. The ambulacral furrows are shown in our specimen as open gutters and we suppose they were covered with small plates, such as cover arm furrows, which have not been preserved. From some fragments that occur on our specimen, that are not shown in the illustration, we are led to believe that the vault has a central orifice on the summit, possibly covered with small plates, in the same way we have supposed the ambulacral grooves to have been covered.



The external appearance of the calyx of this species somewhat resembles *P. allophylus* and *P. brittis*, but the differences are sufficient to at once distinguish it, if attention is paid to the form and to the articulating facets on the first radials. The differences are so great that no descriptive comparisons will serve any one in distinguishing them. But the vault, in this species, is wholly different from either of the above mentioned species and from that of any other known *Platycrinus*. If generic distinctions can be founded upon the vault, then this species does not properly belong to *Platycrinus* or to any other described genus. But, as we have only a fragment of the vault, we would not be justified in founding a genus upon it. We are convinced, that it properly belongs to the family *Platycrinidae* and is nearer, in structure, to *Platycrinus* than to any other described genus, and hence, provisionally, refer it to that genus.

Found by the veteran collector and learned geologist, R. A. Blair, of Sedalia, Missouri, in the Choteau limestone of that locality, and now in the collection of S. A. Miller.

#### BARYCRINUS EXPANSUS, n. sp.

*Plate IV, Fig. 2, view of the calyx, azygous side below.*

Species very large, robust. Calyx more than twice as wide as high; plates very thick, highly convex; sutures distinct, sunken at the angles. Column large, pentagonal.

Basal plates comparatively small, less than one-fourth as large as the subradials, wider than high, and forming a very shallow, pentagonal, saucer-shaped cup. Subradials four or five times as large as the basals, a little wider than long, nearly equal in size, four hexagonal and one, on the azygous side, which is very broadly truncated for the azygous plate, heptagonal. First radials larger than the subradials, about three times as wide as high, nearly equal in size, remarkably thick, and truncated a little more than half the width for the reception of the second radials. The ambulacral notch very small, and facet for the second radials nearly perpendicular or having an inclination of not more than ten degrees. Azygous plate quadrangular, wider than high and a little more than half as large as a subradial.



Comparing this species with *Barycerinus magnificus*, it will be found to be proportionally much more expanded, and consequently the first radials are much wider in proportion to their length, and the facets for the second radials are larger and face nearer horizontally. The plates, too, are much more convex and deeper sunk at the angles, and in these respects, it has some resemblance to *B. herculeus*. It cannot be mistaken for either of those species nor for any other hitherto described.

Found in the Keokuk Group, in Tennessee, and now in the collection of Wm. F. E. Gurley.

### FAMILY SYNBATHOCRINIDÆ.

#### SYNBATHOCRINUS ANGULARIS, n. sp.

*Plate IV. Fig. 3, lateral view showing the greater diameter: Fig. 4, azygous side view.*

Species below medium size. Plates angular. Arms very much constricted at the top of the second radials. Our specimen appears to be in its normal shape, but the calyx and arms are compressed laterally, so the diameter is nearly twice as great one way as the other, while the column is perfectly round and composed of rather long plates. Surface of all the plates granular.

The basals have a pentagonal form externally, the two shorter sides being the anterior and posterior ones, the longer side being the right lateral one when facing the azygous area, and the other two being the left lateral ones. This gives to the little cup, formed by the basal plates, a greater diameter antero-posteriorly than laterally and shows the calyx is in its normal condition, and not flattened by pressure. First radials of unequal width, and each one longer than wide. Each one is beveled from the central part toward the sutures, which makes each one subpyramidal. They are truncated the entire width above for the second radials, and in addition to both plates being beveled to the suture, the suture is slightly gaping. The second plates are rather longer than wide, quadrangular, taper a little upward to meet the constriction of the arms at the commencement of the third plate, or, in other words, the dip in toward the constriction. They, and all the other plates of the arms are beveled laterally to the sutures so that the central part of each arm is one continuous angular ridge. While the calyx

does not appear to be pressed out of shape, the arms are pressed together a little, so as to make them thinner, laterally, than they should be. The plates preserved in our specimen are longer than wide. The first azygous plate is more than twice as long as wide, rests in a notch between two first radials, truncating the one on the right more than the one on the left, and extends nearly to the top of the second radials. It is followed by two plates, the larger one extending down, on one side, one third the length of the plate, and the smaller one truncating the upper side. These two plates are followed by a triangular plate that reaches nearly to the top of the third radials.

The peculiar, flattened calyx, subpyramidal, angular and beveled plates and arrangement of the azygous plates distinguish this from all other described species.

Found in the Keokuk Group, at Button Mould Knob, Kentucky, and now in the collection of Wm. F. E. Gurley.

#### FAMILY ICHTHYOCRINIDÆ.

##### ICHTHYOCRINUS CLARKENSIS, n. sp.

*Plate IV, Fig. 5, lateral view of a compressed specimen.*

Species small. Our specimen is compressed, but the general form with the arms folded is subovate. The plates are free from spines and nodes; the sutures are very distinct and slightly arcuate, the superior plates generally overlap the inferior ones in the middle part. The column is very large and entirely covers the basals and subradials so they have not been observed. There are no interradians.

There are three primary radials in each series. They widen rapidly and are subequal in length. The different series interlock instead of having a straight separating suture. There are four secondary radials in each series of about the same length, and each plate has about the same length as a primary radial, they expand very little, so that the fourth or axillary plate is not much wider than the first plate. The different series interlock in the same manner that the primary series do. The fourth plate supports upon each upper sloping side a single non-bifurcating arm, which gives to the species twenty arms. The arms are composed of short quadrangular plates, with arcuate sutures. There

are twelve plates, in some of the arms, on our specimen, and if complete there would probably be as many more.

This species cannot be confounded, with any other, from rocks of the same age, nor, indeed, with any hitherto described.

Found in the Keokuk or Warsaw Group, in Clark county, Indiana, and now in the collection of Wm. F. E. Gurley.

ICHTHYOCRINUS SPINOSULUS, n. sp.

*Plate V, Fig. 4, view of a compressed specimen, with part of the spines on the first radials broken off.*

Our specimen is compressed, but the true form with the arms folded is roughly ovoid. Distinct sutures separate the plates. All axillary plates bear a central spine and there are occasional spines on other plates. The entire surface is papillose or very strongly granular. The column is large, round, tapers rapidly from the body and is composed of thin plates. The basals and subradials are entirely covered by the head of the column and have not, therefore, been observed. There are no interradians.

Primary radials, three in each series; they gradually widen, but are not of exactly the same length and hence there is a slight interlocking of plates, instead of straight sutures separating the different series. The first primary radials are rather longer than either of the others and each bears a remarkably strong spine, that is directed downward, by the side of the column. The second primary radials are arcuate in the middle of the upper face for the projection of a lip or flange from the third plates and each bears three small spines, one central and one on each side. The third primary radials have steep superior sloping sides, each bears a strong central knob or short spine, and two small spines, one on each side. They are axillary and bear on each upper sloping side three secondary radials.

The first and second secondary radials are of about the same size, arcuate, and are produced transversely in a sharply convex central ridge with three obscure nodes on each. The third secondary radials are larger and longer and each bears a very strong central node or obtuse spine, and supports upon each upper sloping side a single arm or tertiary series. There are, therefore, twenty arms in this species. Each arm is composed of a single series of plates united by arcuate instead of transverse sutures. The arms are infolded and broken at the superior end of our

specimen, but as many as thirty plates may be counted in a single arm. Some of the arm plates bear a central spine or node, but there is not uniformity in the different arms in this respect.

This species is remarkable for its spines, nodes, and rough, uneven, external surface, and is distinguished, by its structure and the number of plates in the primary and secondary series, from all other species.

It was found in Clark county, Indiana, in what is called the Knobstone, but which we think must be of the age of the Keokuk Group, and is now in the collection of Wm. F. E. Gurley.

### FAMILY DOLATOCRINIDÆ.

#### DOLATOCRINUS AMPLUS, n. sp.

*Plate IV, Fig. 6, basal view; Fig. 7, side view; Fig. 8, summit view.*

Calyx large, subcylindrical or bowl-shaped, concave below. All the plates are ventricose or subspinous and radiately furrowed toward the margins. Our specimen is injured at the point of the columnar attachment and part of the radial plates are destroyed.

Basal plates not observed. First primary radials probably as wide or wider than long. Second primary radials quadrangular, a little wider than long. The calyx will rest on these plates and the first interradials. Third primary radials larger than the second, wider than high, pentagonal and bear upon each upper sloping side a single secondary radial. The secondary radials are axillary and bear upon each upper sloping side four or five tertiary radials. There are, therefore, four arms in each series or twenty arm openings to the vault.

The first interradials are the largest plates in the calyx. Four of them have nine sides each, while the azygous plate has eleven sides. In the regular areas the first plate separates the primary and secondary radials and is broadly truncated on top for a second plate that separates the secondary and first tertiary radials and is slightly truncated on top by a small plate in the third range, and this is followed by two small plates in the fourth range which connect with small plates that separate the arms and unite with the plates of the vault. The difference between the azygous area and the other areas is very slight and consists in



the fact, that the first plate abuts against the first tertiary radials and that the second plate is followed by two plates in the third range instead of one.

The vault is convex, slightly depressed in the interrarial areas and apparently bears a subcentral proboscis. The plates are anchylosed in our specimen, and show none of the sutures, and, possibly the hole, which we suppose indicates a proboscis, may be only a hole broken into the vault. There are two orifices between each of the arms that penetrate the vault horizontally. They appear to be excurrent and are of the same character as those in *D. grandis*, *D. lacus*, *D. marshi*, *D. stellifer* and *D. approximatus*.

This species is so distinct from all others that have been described, that no comparison with any of them is necessary.

Found in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

#### FAMILY ACTINOCRINIDÆ.

##### ACTINOCRINUS MONTICULIFERUS, n. sp.

*Plate IV, Fig. 1, view of calyx azygous side on the right.*

This is a remarkably large and robust species, the plates are thick and each one bears a more or less ventricose central node, and the larger plates are radiately sculptured toward the margins. The interrarial areas are depressed, giving to the calyx a pentagonal outline.

Basals truncated below so as to have a diameter at the base, equal to about twice the height, they stand upright and are strongly beveled toward the lateral sutures. The middle part of the base has a hemispherical depression for the insertion of the column, leaving a wide flattened rim around the head of the column. First primary radials much smaller than the basals, longer than wide, three hexagonal and two heptagonal. Second primary radials wider than high, hexagonal and less than half as large as the first. Third primary radials in some of the rays hexagonal, larger than the second, wider than high and support on the superior sloping sides the secondary radials. There is a single secondary radial in each series, somewhat smaller than the third primary, wider than high, some heptagonal and others hex-



agonal, and each supports upon the superior sloping sides the tertiary radials. In the ray on the left of the azygous area there are three tertiary radials in each literal series and two in each of the proximal series, the second of which are axillary and bear upon the superior sides quaternary radials, and thus there are six arm openings to the vault in this ray. If the rays are uniform in this respect there are thirty arms in this species. Three of them are evidently alike in this regard, and we have no reason to think the other two are different, but they are so injured in our specimen that it cannot be definitely determined.

There are two small intertertiary radials, one following the other in each ray. There are eight plates in each regular interradial area, the first one is hexagonal, larger than a second primary radial, and it is followed by two plates in the second series, three in the third and two in the fourth which connect through a sharply depressed sunken area with the plates of the vault. There are eleven plates in the azygous area, the first one is rather larger than a first primary radial and in line with them, it is followed by two plates in the second series, three in the third, three in the fourth and two in the fifth, which connect in a sharply depressed area with the plates of the vault.

The vault is covered with large polygonal plates, each one of which is possessed of a remarkably large ventricose central node. It is sharply depressed toward the interradial areas and bears a large subcentral proboscis, which is broken off in our specimen at the summit of the vault.

This species is distinguished by its great size, the number of arms, the number and position of the plates in the interradial and azygous areas and the ventricose nodes on the surface.

Found in the Keokuk Group in Tennessee, and now in the collection of Wm. F. E. Gurley.

ALLOPROSALLOCRINUS CELSUS, n. sp.

*Plate IV, Fig. 9, view opposite azygous area; Fig. 10, azygous view of same; Fig. 11, basal view of same specimen.*

This species has a vault considerably higher than its greatest diameter, and most ventricose opposite the azygous side. The calyx is convex, at the basals, flat over the radial areas and moderately

depressed in the interrarial areas. The plates are all nodose or subspinous. The column is round, radiately furrowed and pierced by a large cinque foil columnar canal.

The basals are of equal size, have an hexagonal outline and form, a nodose rim around the end of the column. First radials bear a high, transverse, sharp node. Second radials, short, wide, quadrangular. Third radials pentagonal, small; three of them bear upon each of the upper sloping sides, three secondary radials giving two arms to each of the three rays. The other two rays adjoin the azygous area and the most distant sloping sides of the third radials bear three secondary radials and the proximal sloping sides bear a tertiary radial which is axillary and bears upon each of the upper sloping sides three tertiary radials, which gives to each of these rays three arms. There are, therefore, twelve arms in this species and twelve ambulacral openings to the vault.

The first regular interradians rest between the upper sloping sides of the first radials and separate the second and third primary and first secondary radials. Each of these plates bears a very large node and is followed by a single plate which in turn is followed by two plates that connect with the plates of the vault. The first azygous plate is in line with the first radials and is followed by three plates in the second range, two in the third range and two in the fourth range that connect with the plates of the vault.

The vault is somewhat conoidal, remarkably large, and covered with convex, tumid and subspinous plates.

Found in the Warsaw Group, in Tennessee, and now in the collection of Wm. F. E. Gurley.

DORYCRINUS GREENEI, n. sp.

*Plate V, Fig. 1, basal view; Fig. 2, azygous side view, injured in the region of the opening; Fig. 3, summit view, showing the broken bulb over the azygous side and part of the plates over two rays.*

Species large and robust. Calyx rudely pentagonal in outline, by reason of the elevated radial ridges; broadly truncated below for the attachment of a large column; breadth two and a half times as much as the height to the base of the arms; plates very thick and more or less convex; radial ridges, increasing in convexity as far the third primary radials, the upper parts of which are directed nearly horizontally; sutures beveled; surface sculptured.

Basals form a short subhexagonal disc, gently concave below for the attachment of the column, and pierced by a round or slightly cinque foil opening for the columnar canal. First radials large, of unequal size, rapidly expanding to the lateral angles, one-half wider than higher, three hexagonal and two heptagonal; the two hexagonal plates adjoining the azygous area are smaller than the others. Second radials about two-thirds the size of the first and of unequal size and shape; the one opposite the azygous area is quadrangular, and twice as wide as high, and anchylosed with the third radial, so the suture is very indistinct in our specimen. The others are more or less distinctly hexagonal, depending upon the truncation of the superior lateral angles, by the adjacent interradials; some of the angles are broadly truncated, and others barely touched. The second radials are much more convex longitudinally than the first, which gives the calyx at this place a marked pentagonal outline. The third radials are of very unequal size, smaller than the second, from one and a half to two and a half times as wide as high, pentagonal, axillary, and have the superior angles directed almost horizontally, and from these plates upward the rays are all directed horizontally. The third radial on the right of the azygous area bears upon each upper sloping side a single secondary radial which is short, wide, pentagonal and axillary, and bears upon each upper sloping side at least three tertiary radials before the arms are free from the plates of the vault. This arrangement gives to this ray four arms. The third primary radials in each of the other four radial series bear upon the left upper sloping side a single secondary radial, which bears upon its upper sloping sides at least three tertiary radials, but the other sloping side of the third radial bears only secondary radials, which gives to each of these four radial series three arms. The species, therefore, possesses sixteen arms before they become free from the plates of the calyx and vault. The arms consist of a single series of transverse plates, but we know nothing of what bifurcations, if any, take place. The plates of the vault and interradial areas cover the top and sides of these horizontal extensions of the secondary and tertiary radials, leaving the interradial areas deeply depressed between them.

The first regular interradial, in each area, is a large plate that rests between the superior sloping sides of the first primary radials, separates the second primary radials, and supports upon its upper

sloping sides two rather large plates that separate the secondary and tertiary radials. These plates in the second interrarial range unite with the plates of the vault and the sides of the projecting radial series, but our specimen is too much injured to follow further the order of arrangement.

The first azygous plate is heptagonal, of the same size and in line with the first primary radials. It is followed by three rather large plates in the second range, that separate the second primary radials, and, in turn, these are succeeded by a range of five somewhat smaller plates that separate the adjacent secondary and tertiary radials. The third range, as thus indicated, is succeeded by ranges of plates that cross the wide azygous area and form the sides of the projecting radial series and thus unite with and become part of the plates belonging to the vault. The graduation from the plates of the calyx to those of the vault leave no definite line of separation between them.

The vault is convex and possessed of a balloon-like prominence on the azygous side, part of which only is preserved in our specimen, but it is certainly peculiar and distinct from that belonging to any other described species. The opening appears to have been seven or eight ranges of plates higher than the third range of plates in the azygous area. All the radial areas are high, with abruptly descending interrarial areas to correspond with the horizontally projecting arms above described. The plates of the vault and balloon-shaped prominence are large, convex and polygonal, with a smooth or finely granular surface. The plates directly over the junction of the ambulacral passages bear spines and each one over the junction of the ambulacral passages belonging to the five radial series is particularly robust, though not of great length. Our specimen is too much injured upon the vault for a minute and careful definition of it, but the injury is mechanical and what we have is in a good state of preservation.

This is a remarkable species, and quite distinct from all hitherto described, though we think it is clearly referable to *Dorycrinus*.

Found by G. K. Greene, in whose honor we have proposed the specific name, in what is called the Knobstone Group, at Button Knobs, in Bullitt county, Kentucky, and which we suppose is the age of the Keokuk Group. The specimen described is now in the collection of Wm. F. E. Gurley.



## BATOCRINUS COPIOSUS, n. sp.

*Plate V, Fig. 5, azygous view of calyx and vault; Fig. 6, opposite view of same, specimen slightly compressed.*

Body rather above medium size. Calyx broadly truncated at the base, one-half wider than high, arm openings directed twenty degrees above a horizontal line; plates thick, convex; sutures distinct; surface granular.

Basals short, thick, and forming a low, hexagonal cup, four times as wide as high, with a round hemispherical depression radiately furrowed for the attachment of the column. The thickness of the plates outside the column is about equal to half its diameter. They stand upright and are beveled toward the sutures. First radials the largest plates in the calyx, twice as wide as high, unequal in size, three hexagonal, two heptagonal, and each one bears a highly convex, transverse, obtusely angular ridge. Second radials small, quadrangular, and more than twice as wide as long. Third radials small, pentagonal, rather wider than the second, about twice as wide as high, axillary, and bear upon each upper sloping side the secondary radials. There are two secondary radials in each series except in one opposite the azygous area where there are four secondary radials upon each side of the third radial. The first secondary radials in the four series are small and quadrangular. The second secondary radials in the four series are rather large, wide plates, bearing a transverse ridge, axillary, and support upon each upper sloping side three tertiary radials. There are, therefore, four arms, in each of four series, and two arms in the ray opposite the azygous side, or eighteen arm openings to the vault.

There is only a single regular interr radial in each area, one has nine sides, another ten, another eleven and the other twelve sides. Each one bears a prominent central node. There are four plates in the azygous area; the first one is larger than a regular interr radial, is in line with the first radials, though somewhat higher, and bears a transverse convex ridge, it is followed by three plates, each about the size of a regular interr radial and each bearing a central node.

The vault is quite as large as the calyx, most ventricose on one side, and bears a subcentral proboscis. It is covered by large, nodose, polygonal plates. There are two pores penetrating the vault between each of the radial series.



There is of course some resemblance between all species of *Batocrinus* having, as in this case, a subequal calyx and vault; but there is no necessity for comparing this species with any of them bearing eighteen arms, as the least care will distinguish it.

Found in the Kaskaskia Group, on Little Barren river, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS SACCULUS, n. sp.

*Plate V, Fig. 7, view of calyx, vault and part of the column, opposite the azygous area; Fig. 8, basal view, azygous side up; Fig. 9, summit view of same, azygous side down.*

Body medium size. Calyx somewhat saucer-shaped, three times as wide as high; arms directed horizontally; plates convex; sutures distinct; surface granular. Our specimen is a little depressed below, so as to produce an unnatural concavity around the column, and, therefore, does not show the full height of the calyx; it appears to be four times as wide as high, but remove the depression and it will not be more than three times as wide as high. The column is round, and plates rather thick and beveled toward the sutures so as to make them sharply angular in the middle.

Basals small, low, and extending only a little beyond the column. First radials small, one-half wider than high. Second radials two-thirds as large as the first, quadrangular and only a little wider than long. Third radials very little larger than the second, four pentagonal, the one opposite the azygous area heptagonal, axillary and bear upon each upper sloping side the secondary radials. There are two secondary radials in each series, four of which are axillary and bear upon each upper sloping side a tertiary radial. In the ray opposite the azygous area the second secondary radials are rather large and bear the free arms. This gives to the species eighteen arms. The arms are small and directed horizontally.

There are three plates in each regular interrarial area, the first are the larger plates of the calyx, and each is followed by two rather long plates. In one or two of the areas there is a small plate above these. The first azygous plate is a little larger than the first radials and it is followed by four plates in the second series; above these the sutures are obscure in our specimens but apparently there are three in the third series and above these there is one or two plates that connect with the plates of the vault.

The vault is convex, most venticose on the side opposite the azygous area. It is fully as large as the calyx and bears a very small subcentral proboscis. It is covered with rather large, polygonal, convex plates, and is slightly depressed in the interradianal reas.

This species somewhat resembles in form, *B. spergenensis*, but differs in the interradianal and azygous areas, beside that is a twenty armed species while this has only eighteen. It will not be mistaken for any hitherto described.

Found in the Warsaw group, in Washington county, Indiana, and now in the collection of Wm. F. E. Gurley.



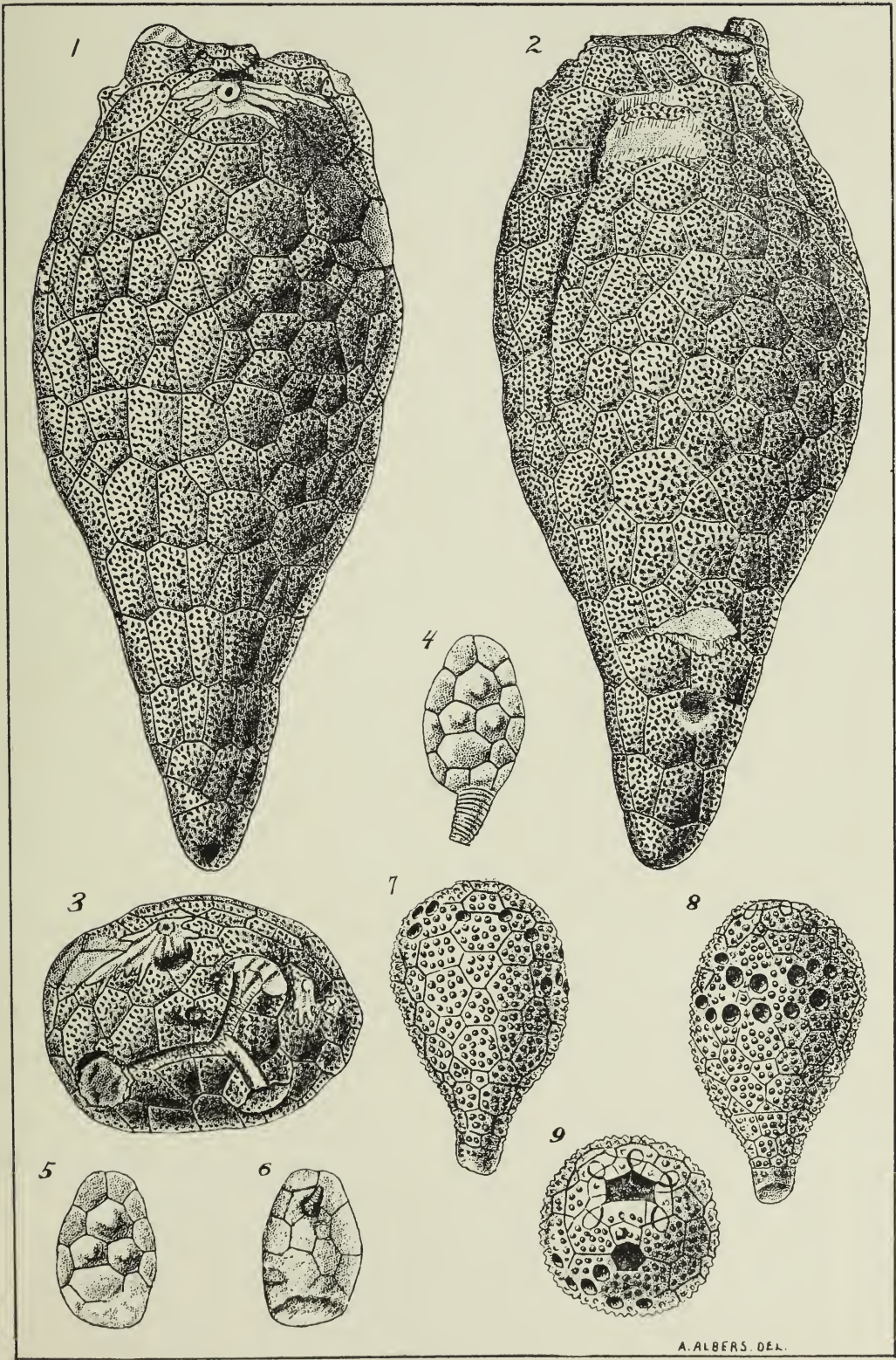


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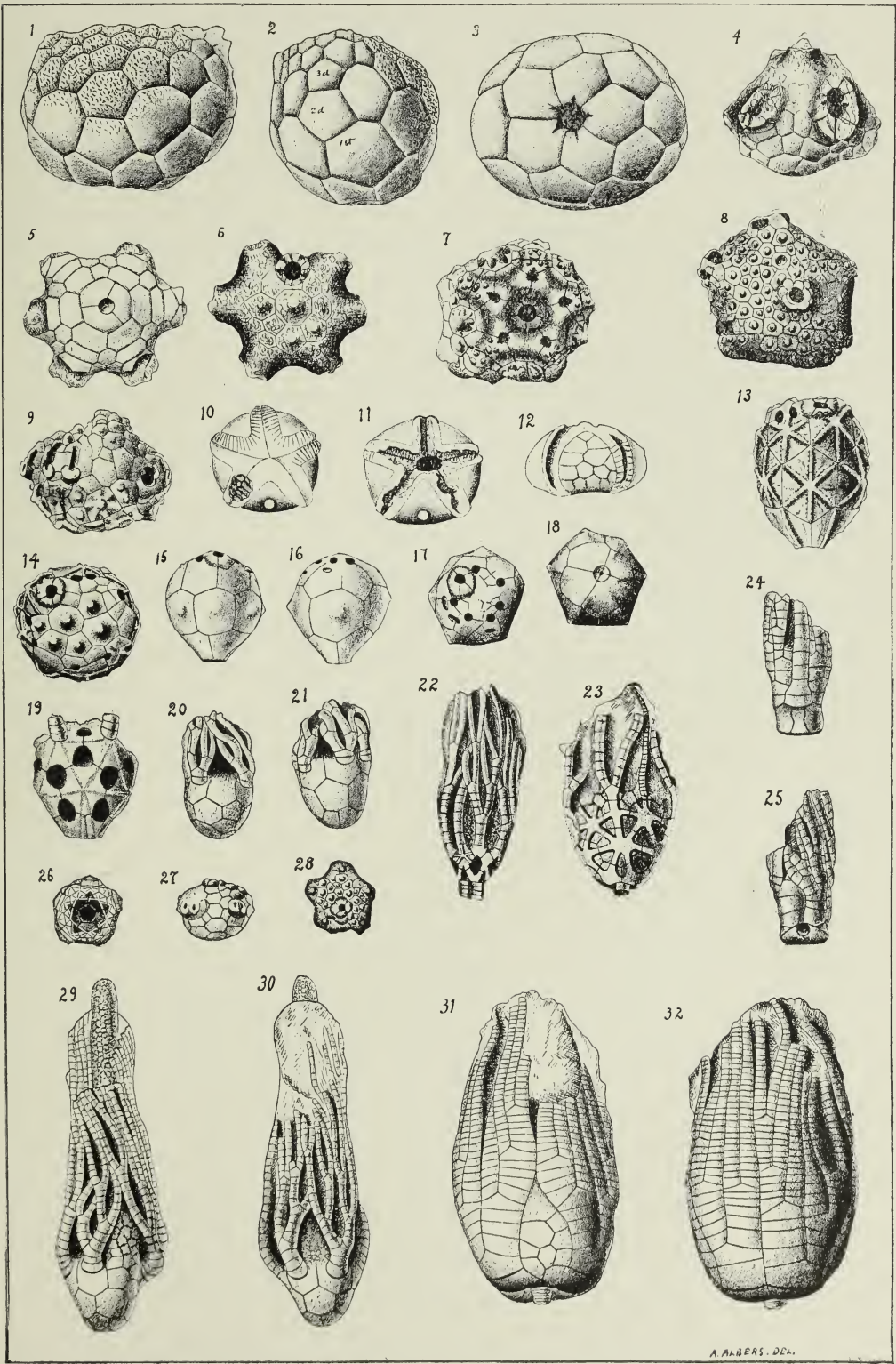


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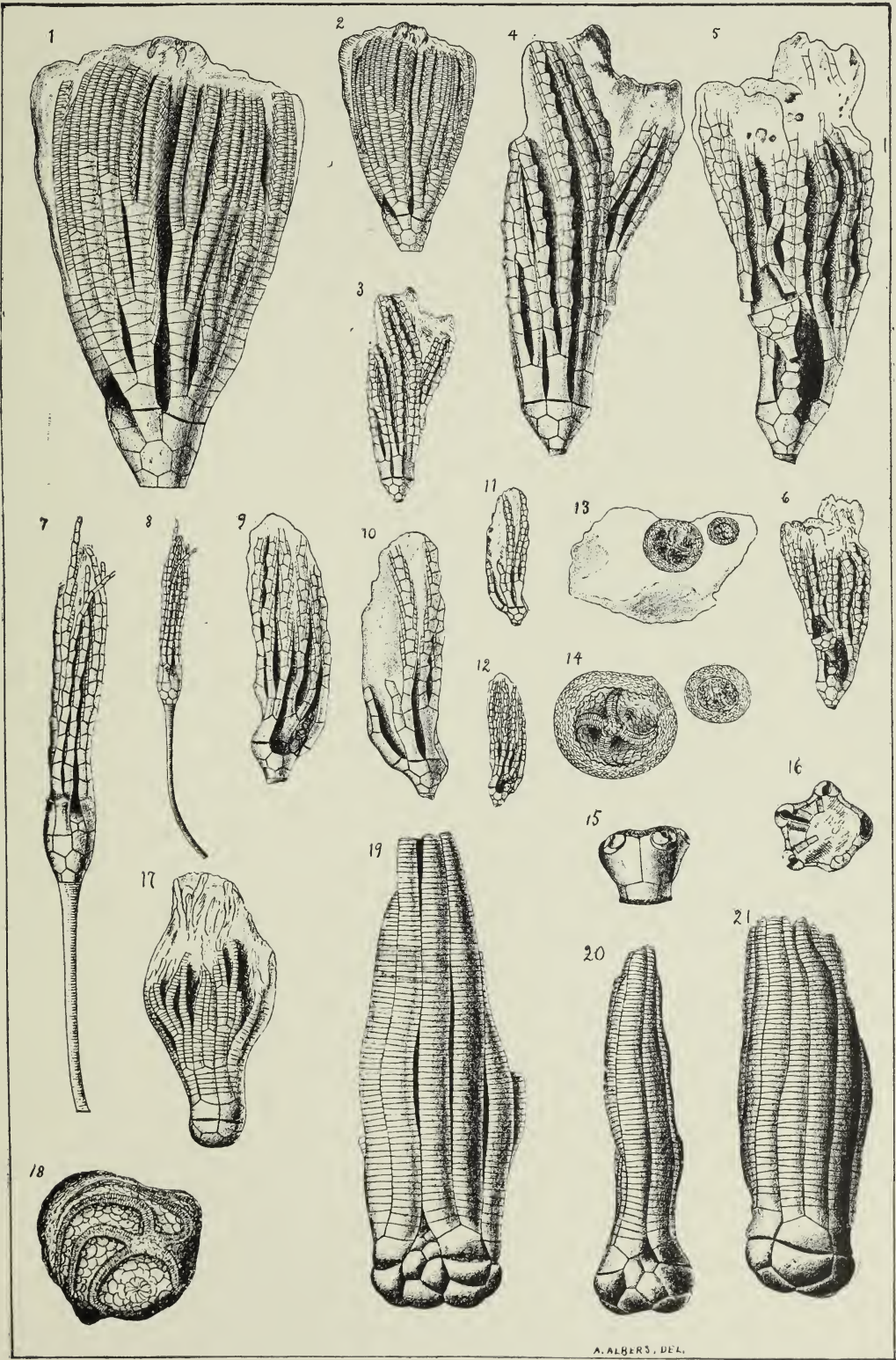




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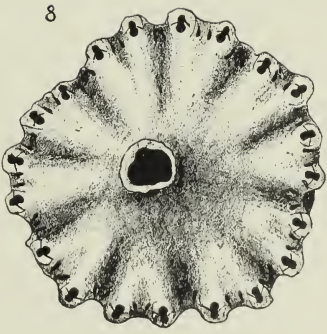
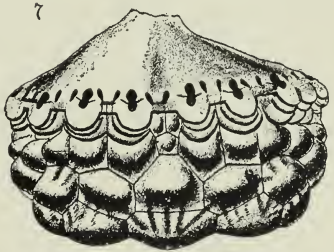
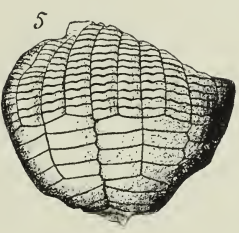
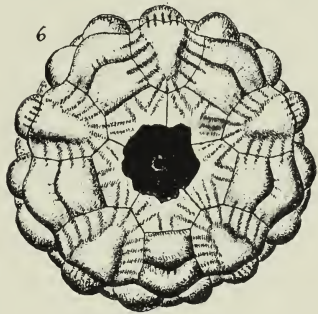
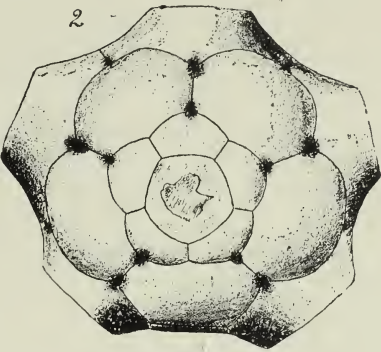
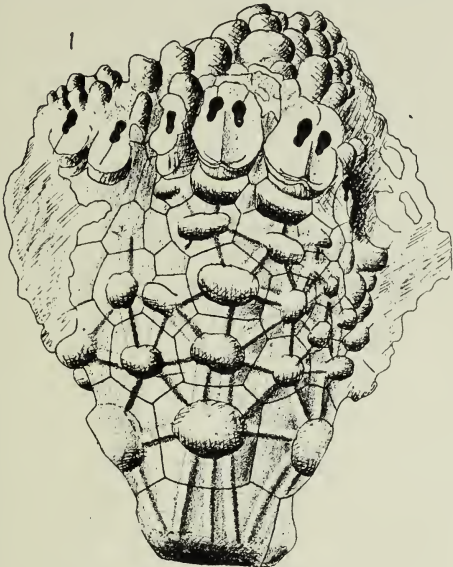




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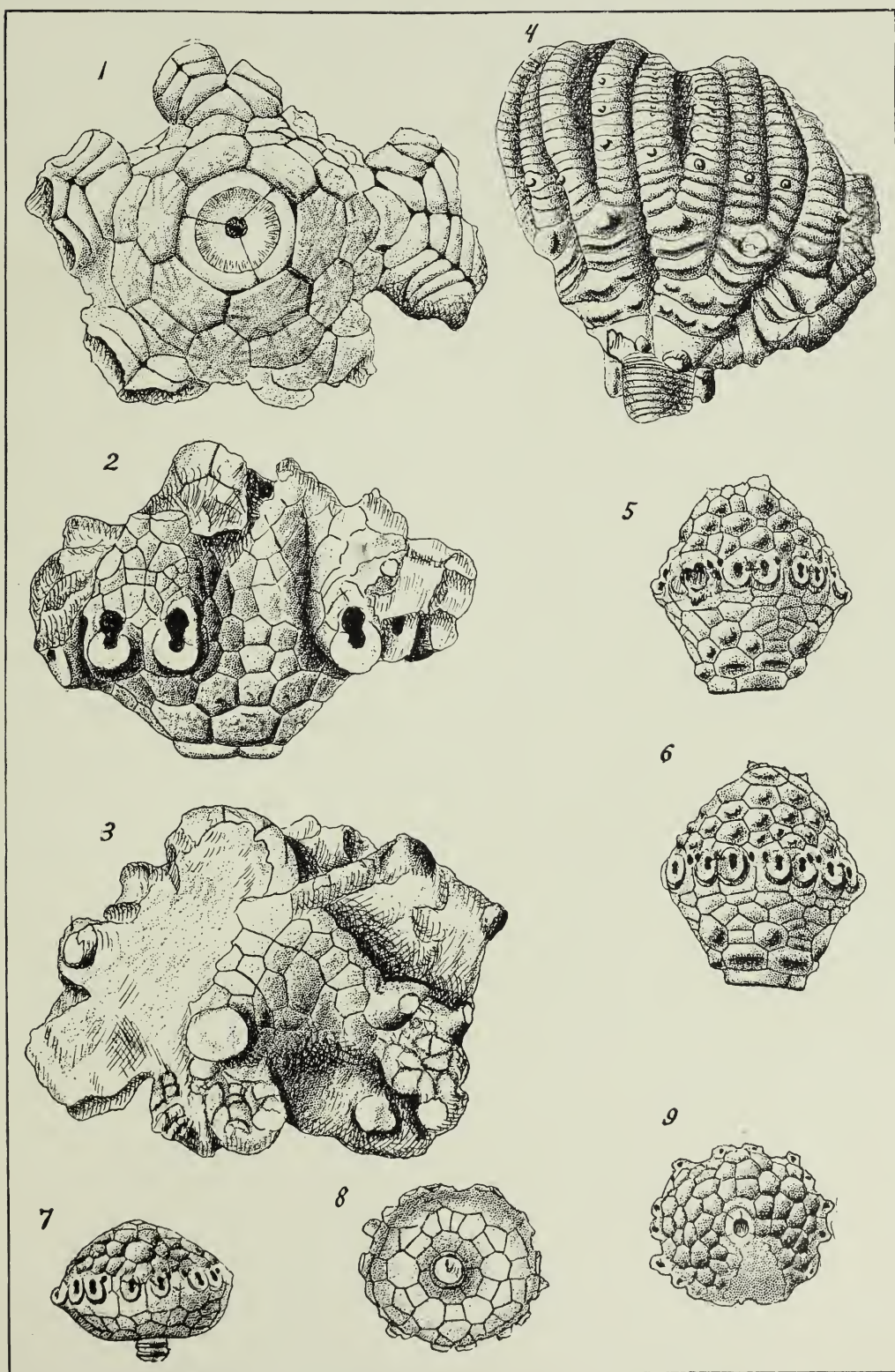




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